ENVIRONMENTAL SENSITIVITY INDEX: SOUTHERN CALIFORNIA

INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been developed for the shoreline of southern California to encompass the coastal areas from the U.S./Mexico border to Point Conception. The ESI maps include information for three main components: shoreline habitats; sensitive biological resources; and human-use resources. The methods of data collection and presentation are summarized in the following sections.

SHORELINE HABITAT MAPPING

The intertidal habitats of southern California, which cover the shoreline between the U.S./Mexico border to Point Conception, were mapped during overflights and ground surveys conducted from 12-14 October 1993. The aerial surveys were conducted using the California Department of Fish and Game Partenavia, flying at elevations of 300-500 feet and slow air speed. Mapping was restricted to two hours on either side of low tides during daylight hours. An experienced coastal geologist delineated the intertidal habitats directly onto 1:24,000 scale U.S. Geological Survey topographic maps. Where appropriate, multiple habitats were delineated for each shoreline segment.

Prediction of the behavior and persistence of oil on intertidal habitats is based on an understanding of the dynamics of the coastal environments, not just the substrate type and grain size. The vulnerability of a particular intertidal habitat is an integration of the following factors:

1) Shoreline type (substrate, grain size, tidal elevation, origin)
2) Exposure to wave and tidal energy
3) Biological productivity and sensitivity
4) Ease of cleanup

All of these factors are used to determine the relative sensitivity of intertidal habitats. Key to the sensitivity ranking is an understanding of the relationships between: physical processes, substrate, shoreline type, product type, fate and effect, and sediment transport patterns. The intensity of energy expended upon a shoreline by wave action, tidal currents, and river currents directly affects the persistence of stranded oil. The need for shoreline cleanup activities is determined, in part, by the slowness of natural processes in removal of oil stranded on the shoreline.

These concepts have been used in the development of the Environmental Sensitivity Index (ESI), which ranks shoreline environments as to their relative sensitivity to oil spills, potential biological injury, and ease of cleanup. Generally speaking, areas exposed to high levels of physical energy, such as wave action and tidal currents, and low biological activity rank low on the scale, whereas sheltered areas with associated high biological activity have the highest ranking. The list below includes the shoreline habitats delineated for southern California, presented in order of increasing sensitivity to spilled oil.

1A) Exposed Rocky Cliffs
1B) Exposed Seawalls
1C) Exposed Rocky Cliffs with Boulder Talus
2) Exposed Wave-cut Platforms
3) Fine- to Medium-grained Sand Beaches
4) Coarse-grained Sand to Granule Beaches
5) Mixed Sand and Gravel Beaches
6A) Gravel Beaches
6B) Riprap
7) Exposed Tidal Flats
8A) Sheltered Rocky Shores
8B) Sheltered Man-made Structures
9) Sheltered Tidal Flats
10) Marshes

Each of the shoreline habitats are described in the following pages, in terms of their physical description, predicted oil behavior, and response considerations. Summary statistics are given for each shoreline habitat, in terms of the percent of the total shoreline length as mapped in southern California. These statistics were calculated by summing the shoreline lengths for each habitat type, double counting the segments where more than one shoreline type was mapped. Therefore, even though the length of actual shoreline mapped, which includes bays and the lower parts of rivers, was determined to 1,714 kilometers, the sum of all classified shorelines was 1,880 kilometers.

SENSITIVE BIOLOGICAL RESOURCES

California Department of Fish & Game (CDF&G) regional biologists in the Office of Oil Spill Prevention and Response (OSPR) compiled the biological information presented on the maps. Information collected and depicted on the maps denotes the key biological resources that are most likely at risk in the event of an oil spill. Six major categories of biological resources were considered during production of the maps: birds, fish, shellfish, mammals, plants, and reptiles.

Spatial distribution of the species on the maps is represented by polygons, lines, and points, as appropriate. Associated with each of these representations is an icon depicting the types of plants or animals that are present. Species have been divided into groups and subgroups, based on their behavior and taxonomic classification. The icons reflect this grouping scheme. The groups are color coded, and the subgroups are represented by different icons as follows:

BIRDS

- Alcids and Pelagic Birds
- Diving Birds
- Gulls and Terns
- Raptors
- Shorebirds
- Wading Birds
- Waterfowl

FISH

- Fish

MAMMALS

- Dolphins
- Sea Otter
- Seals and Sea Lions
- Whales

PLANTS

- Kelp and Seagrass
- Terrestrial Plants
- Intermittent Coastal Wetlands

REPTILES

- Turtles

SHELLFISH

- Bivalves
- Crabs
- Echinoderms
- Gastropods and Abalone
- Lobsters
- Squid and Octopus

The polygon, line, or point color and pattern are the same for all the animals in one group. When there is more than one group of animals in one polygon, the polygon is then assigned the multigroup color and pattern. Also associated with each polygon on the map is a number (located under the icon for the polygon). This number references a table on the reverse side of the map with a complete list of species found in the polygon as well as life-history information on each species.

There are some species that are found throughout the nearshore zone on the map. While it is important to note the presence of these species, showing these distributions as polygons would cover large areas. In addition to providing no significant increase in the level of information presented to the user, it would make the maps very difficult to read. In response to this problem, species found in over 25 percent of the water area are identified in a box stating that they are “COMMON THROUGHOUT”. This approach informs the user of the presence of these species, while maintaining readability of the map.

BIRDS

Birds are divided into several species subgroups based on behavior and taxonomy. The species table lists all the birds included on the maps sorted by subgroup. These species were included either because of their likelihood of impact by an oil spill or special protection status as threatened or endangered. Bird distribution is shown on the maps as points and polygons. Green dots on the maps depict known nesting sites. Bird polygons are shown as a green hatch pattern; however, if species in addition to birds are in the polygon, a black hatch (multigroup) pattern is used. The number under the icon references a table on the reverse side of the map. In this table, the first column gives the species name, followed by the state (S) and/or federal (F) species designation for endangered (E) or threatened (T) status. The next column provides an estimate of the concentration of species at this site. Concentration is typically indicated as ‘HIGH’, ‘MED’, or ‘LOW’. These are very subjective values based on local expert opinion on the relative concentrations in the area. If the actual bird counts are available, as for nesting sites, then the actual count will be shown. The species seasonality is shown in the next twelve columns representing the months of the year. If the species is present at that location in a particular month, an 'X' is placed in the month column. The last four columns denote the times for nesting, laying, hatching, and fledging at this site. For many species there is a temporal shift along with the spatial change, so all the temporal information included in the table is specific to the one polygon or point that it references.

FISH

Fish distributions shown on the map represent spawning areas, areas of particularly high concentrations of selected species, and anadromous streams. The species table lists all the fish included on the maps sorted by subgroups. Because these assemblages include many similar species only one icon is used for all fish, instead of one icon for each subgroup as with the other groups. Concentration or spawning areas for fish are shown as polygons on the map. Fish polygons are shown as a blue hatch pattern; however, if species in addition to fish are in the polygon, a black hatch (multigroup) pattern is used. Anadromous fish streams are shown as a thick blue line. Blue icons are associated with both the polygons and the streams. The number under the icon references a table on the

reverse side of the map. In this table, the first column gives the species name. The second column denotes whether the species has been designated endangered (E), threatened (T), or special concentration (SC) status on either the state (S) or federal (F) list. The next column provides an estimate of the concentration of species at this site. Concentration is indicated as 'HIGH', 'MED', or 'LOW'. These estimates are very subjective values based on local expert opinion on the relative concentrations in the area. The species seasonality is shown in the next twelve columns, representing the months of the year. If the species is present at that location in a particular month, an 'X' is placed in the month column. The last two columns denote normal times for spawning (all fish) and outmigration (anadromous fish). For many species there is a temporal shift along with the spatial change, so all the temporal information included in the table is specific to the one polygon or line that it references.

MAMMALS

Coastal California has numerous species of marine mammals that potentially may be impacted by an oil spill. Because of the wide diversity in mammals, both behaviorally and physically, the mammals have been divided into subgroups. Each of these subgroups is represented by a different icon. The species table lists all the species of mammals shown on the maps, sorted by subgroup. In addition, there are a few species of terrestrial mammals that might also be impacted. Concentration areas of the pelagic species (dolphins, porpoises, and whales) are shown on the map, and the general distributions are indicated in the "COMMON THROUGH-OUT" box. Mammal distribution on the maps is shown by a brown hatch polygon. However, if species in addition to mammals are included in the polygon, a black hatch (multigroup) polygon is used. The number under the icon references a table on the reverse side of the map. In this table, the first column gives the species name. The second column denotes whether the species has been designated endangered (E) or threatened (T) status on either the state (S) or federal (F) list. The next column provides an estimate of the concentration of species at this site. Concentration is typically indicated as 'HIGH', 'MED', or 'LOW'. These estimates are very subjective values based on local expert opinions about the relative concentrations in the area. In some cases, such as seal or seal lion haulouts, the actual number of animals likely to be present is indicated. The species seasonality is shown in the next twelve columns, representing the months of the year. If the species is present at that location in a particular month, an 'X' is placed in the month column. The last column indicates the most likely dates for birthing by that species. For many species there is a temporal shift along with the spatial change, so all the temporal information included in the table is specific to the one polygon that it references.

PLANTS

The plants are divided into three subgroups: kelp and sea-grasses; coastal wetlands; and terrestrial plants. The terrestrial plants shown are only those on the state or federal list of threatened or endangered species. Terrestrial plants are seldom directly affected by oil; however, it is possible that cleanup operations might destroy some of the plants or their habitat. The general locations of threatened or endangered plants are shown, so that the appropriate agency can be notified and cleanup and response efforts can be planned accordingly. Intermittent coastal wetlands are located near the mouth of smaller creeks, often with high gradient drainage that generally flow only during the rainy season, after which a small wetland, with sparse to moderate vegetation, remains for several months. The berm builds up usually during late spring through early summer, cutting it off from the ocean. The wetland then completely, or nearly completely, dries up by late summer or fall. The rainy season can begin as early as mid fall (but usually begins early winter).

The species list lists all the plants shown on the maps. The plants, whether terrestrial or aquatic, are shown as polygons with a purple hatch pattern. If species in addition to plants are present in the polygons, a black hatch (multigroup) pattern is used. Purple icons are associated with the polygons, and the silhouette of the subgroup is shown. The number under the icon references a table on the reverse side of the map. In this table, the first column gives the species name. The second column denotes whether the species has been designated endangered (E) or threatened (T) status on either the state (S) or federal (F) list. The next column provides an estimate of the concentration of species at this site. Concentration is typically indicated as 'HIGH', 'MED', or 'LOW'. These estimates are very subjective values based on local expert opinion on the relative concentrations in the area. The last twelve columns provide information on the plants seasonality. All 12 months are marked with an 'X' since the plants are present all year. This method was used to make tables consistent with those of the other species found on the maps.

REPTILES

The only reptile shown on the maps is the sea turtle, specifically the Pacific green sea turtle. A red icon with a turtle silhouette is used indicate the presence of sea turtles.

SHELLFISH

Shellfish include crustaceans and mollusks and have been divided into several subgroups. The species table lists all the shellfish shown on the maps sorted by subgroup. Species that are commercially or recreationally important, or any species that is threatened or endangered are included. The distribution of shellfish is shown as polygons with an orange hatch pattern. If species in addition to shellfish are included in the polygon, a black hatch (multigroup) pattern is used. Orange icons are associated with the polygons, and the silhouette of the subgroup is shown. The number under the icon references a table on the reverse side of the map. In this table, the first column gives the species name. The second column denotes whether the species has been designated endangered (E) or threatened (T) status on either the state (S) or federal (F) list. The next column provides an estimate of the concentration of species at this site. Concentration is indicated as 'HIGH', 'MED', or 'LOW'. These estimates are very subjective values based on local expert opinions on the relative concentrations in the area. The species seasonality is shown in the next twelve columns, representing the months of the year. If the species is present at that location in a particular month, an 'X' is placed in the month column. The last column indicates dates for spawning. For many species there is a temporal shift along with the spatial change, so all the temporal information included in the table is specific to the one polygon that it references.

HUMAN-USE FEATURES

The human-use features depicted on the maps are those that either could be impacted by an oil spill or could provide access to the cleanup operation. All the features are represented by icons indicating the type of feature. If the icon is not placed on the location of the feature, a leader line is drawn from the icon to the proper location.

Access—Sites where beach access by vehicle is possible. This information was provided by CDF&G or observed during the overflights.

Airport—Location of airfields or airports whether they are manned or unmanned. The locations were obtained from visual observations during the overflights or from U.S. Geological Survey (USGS) topographic maps.

Aquaculture—Location of aquaculture facilities including hatcheries and oyster farms. This information was provided by CDF&G.

Archaeological site—Location of known archaeological sites in close proximity to the shoreline. This information was provided by CDF&G.

Boat ramp—Location of boat ramps. This information was from CDF&G, overflight observations, or topographic maps.

Coast Guard—Location of Coast Guard facilities. This information was from CDF&G and topographical maps.

Commercial fishing—Areas heavily used for commercial fishing. This information was provided by CDF&G.

Marina—Location of any marinas. This information was from CDF&G, overflight observations, or topographic maps.

Marine sanctuary—The boundaries for the marine sanctuaries were provided by NOAA. The boundaries were entered based on the latitude/longitude point definitions of the marine sanctuary boundaries.

National park—An icon is used to show the location of the national park, but the digitized boundary was provided by CDF&G.

State park—An icon is used to show the location of the state park, but the digitized boundary was provided by CDF&G.

Recreational fishing/boating—General areas where there is heavy recreational fishing or boating. This information was provided by CDF&G.

Recreational beach—Location of a recreational beach. These sites are indicated with an icon; the beach boundaries were not digitized. Information was provided by CDF&G.

Reserve, preserve, refuge, or area of special biological significance (ASBS)—All boundaries for the reserves, preserves, refuges, or any other managed and regulated wildlife area were provided by CDF&G. The boundary is shown on the map with an icon and the name along the boundary.

Water intakes—Symbol is placed at the location of a water intake. The location information was provided by CDF&G.

For many of these features, the name of the feature, manager/owner, contact, and a phone number were provided. The information is listed below and on the reverse side of the maps. If at least a name is available for the site, it is included in the list.

NAME	PHONE
MARINE SANCTUARIES/ESTUARINE RESERVES	
Channel Islands National Marine Sanctuary	(805) 966-7107
Tijuana Estuary Ecological Reserve	(619) 575-3613
NATIONAL PARK SERVICE LANDS	
Cabrillo National Monument	(619) 237-6766
Channel Islands National Monument	
Channel Islands National Park	(805) 658-5701
Santa Monica Mountains NRA	(818) 888-3770
RECREATIONAL BEACHES	
Arroyo Burro Beach County Park	(805) 568-2461
Cabrillo Beach	
Cardiff State Beach	(619) 753-5091
Carlsbad State Beach	(619) 438-3143
Carpinteria City Beach	(805) 568-2461
Carpinteria State Beach	(805) 684-2811
Doheny State Beach	(714) 496-6171
East Beach	(805) 568-2461
Emma Wood State Beach	(805) 899-1400
Goleta Beach County Park	(805) 568-2461
Goleta Point	(805) 568-2461
Hollywood Beach	
Isla Vista Beach Park	(805) 568-2461
Leadbetter Beach	(805) 568-2461
Leo Carrillo State Beach	(818) 706-1310
Malibu Lagoon State Beach	(818) 706-1310
Mandalay State Beach	(805) 899-1400
McGrath State Beach	(805) 654-4744
Moonlight State Beach	(619) 729-8947
Ormond Beach	
Oxnard State Beach	(805) 899-1400
Pacific Beach	
Point Medanos	
Ponto State Beach	
Port Hueneme Beach Park	(805) 654-3934
Rincon Beach County Park	(805) 654-3934
San Buenaventura State Beach	(805) 654-4611
San Clemente State Beach	(714) 492-5171
San Elijo State Beach	(619) 753-5091
San Onofre Beach	(714) 492-4872
Shoreline Park	(805) 568-2461
Silver Strand Beach	
Silver Strand County Beach	(805) 654-3934
Silver Strand State Beach	(619) 435-5184
Solana Beach County Park	
Solimar Beach	(805) 654-3934
South Carlsbad State Beach	(619) 438-3143
Torrance County Beach	(213) 372-2166
Torrey Pines State Beach	(619) 755-2063
West Beach	(805) 568-2461
RESERVES, PRESERVES, AND REFUGES	
Abalone Cove Ecological Reserve	
Bolsa Chica Ecological Reserve	
Buena Vista Ecological Reserve	
Chula Vista Wildlife Refuge	
Dana Point Marine Life Refuge	
Doheny Beach Marine Life Refuge	
Emory Cove Wildlife Preserve	
Irvine Coast Marine Life Refuge	
Kendall-Frost State Ecological Reserve	
Laguna Beach Marine Life Refuge	
Lover's Cove Reserve	
Newport Beach Marine Life Refuge	
Niguel Marine Life Refuge	
Point Fermin Marine Life Refuge	
San Diego Marine Life Refuge	
San Elijo Ecological Preserve	
Santa Catalina Island ASBS Subarea 1	(310) 590-5180
Santa Catalina Island ASBS Subarea 4	(310) 590-5180
Seal Beach National Wildlife Refuge	(619) 431-9440
South Laguna Beach Marine Life Refuge	
Sweetwater River National Wildlife Refuge	
Tijuana Estuary Ecological Reserve	(619) 575-3613
Torrey Pines State Reserve	
STATE PARKS	
Bolsa Chica Beach State Park	(714) 846-3460
Dockweiler Beach State Park	(213) 322-5008
El Capitan Beach State Park	(805) 968-1033
Huntington Beach State Park	(714) 536-1454
Manhattan Beach State Park	(213) 372-2166
Redondo Beach State Park	(213) 372-2166
Refugio Beach State Park	(805) 968-1033
Santa Monica Beach State Park	(213) 394-3266
Will Rogers Beach State Park	(213) 394-3266

GEOGRAPHIC INFORMATION SYSTEM DATA

The entire atlas product is stored in digital form in a Geographic Information System (GIS). The information is stored as maps and associated databases. The format for the data varies depending on the type of information or features for which the data are being stored. The three major formats are shoreline habitat classification, biological resources, and human-use features.

Under separate cover are a complete data dictionary, metadata, and descriptive information for the digital data sets and maps that were used to create this atlas. Below is a brief synopsis of the information contained in the digital version. Please refer to the metadata file for full explanations of the data and its structure.

SHORELINE HABITAT CLASSIFICATION

The shoreline habitat classification is stored as lines or polygons with the data identifying the type of habitat associated with the line. In many cases, a shoreline may have two or three different classifications. These multiple classifications are represented on the maps by double and triple lines, and in the database by ESI#1/ESI#2 where ESI#1 is the landward-most classification and ESI#2 is the seaward-most classification.

SENSITIVE BIOLOGICAL RESOURCES

Biological resources are shown on the map by colored and shaded polygons, colored lines and dots, and colored icons. The associated table helps to further identify the resources. In the digital copy, the resources are depicted as lines, points, or polygons. Associated with each map feature is a unique identification number which is linked to a series of databases that further identify the resources. The first data set consists of a list of the species, concentration of each species, and an expert contact for the species. This dataset is then linked to a dataset that describes the life history of each species (temporal presence and reproductive times at month resolution) for the specified map feature. Other databases linked to the first data set are the species identification database, which includes common and scientific names for all species and threatened or endangered status, and the experts database, which includes the name, agency, address, phone number, geographical area of expertise, and biological area of expertise for each of the experts referenced.

HUMAN-USE FEATURES

Human-use features are represented on the maps as an icon describing the feature. In the digital file, the feature location is represented by a point, except for managed lands, which are depicted by polygons. Attached to the feature is a data file that contains the fields for the name of the owner/manager, phone number at which the person can be contacted, identification of the type of feature, and a brief description of the feature. This information is incomplete and may change frequently.

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Most of the biological data included on these maps were provided by Heidi Togstad, John Grant, and Robin Lewis of CDF&G. They in turn collected the information from numerous people throughout the state of California. Digital data for the shoreline, seabird nesting colonies, sea otter sitings, pelican roosting areas, and pinniped haulouts were provided by Eric Kauffman of the State Lands Commission. Randy Imai of CDF&G coordinated the digital data collection.

At Research Planning, Inc. (RPI), Jacqueline Michel, Miles O. Hayes, Jeffrey Dahlin, and Scott Zengel were the project scientists. Shoreline mapping was conducted by Miles O. Hayes. Mark White, Lee Diveley, James Olsen, and William Holton entered the data and produced the final maps, under the supervision of Joanne Halls. Graphics were provided by Joe Holmes, and Dot Zaino prepared the text.

SPECIES LIST*

Common Name	Species Name
BIRDS	
ALCIDS AND PELAGIC BIRDS	
Ashy storm-petrel	*Oceanodroma homochroa*
Black storm-petrel	*Oceanodroma melania*
Cassin's auklet	*Ptychoramphus aleuticus*
Common murre	*Uria aalge*
Fork-tailed storm-petrel	*Oceanodroma furcata*
Leach's storm-petrel	*Oceanodroma leucorhoa*
Pigeon guillemot	*Cepphus columba*
Rhinoceros auklet	*Cerorhinca monocerata*
Tufted puffin	*Lunda cirrhata*
Xantus' murrelet	*Endomychura hypoleuca*
DIVING BIRDS	
Brandt's cormorant	*Phalacrocorax penicillatus*
Brown pelican	*Pelecanus occidentalis*
Common loon	*Gavia immer*
Cormorant	*Phalacrocorax sp.*
Double-crested cormorant	*Phalacrocorax auritus*
Pelagic cormorant	*Phalacrocorax pelagicus*
Western grebe	*Aechmophorus occidentalis*
GULLS AND TERNS	
Black skimmer	*Rynchops niger*
Caspian tern	*Sterna caspia*
Elegant tern	*Sterna elegans*
Forster's tern	*Sterna fosteri*
Heermann's gull	*Larus heermanni*
Least tern	*Sterna albifrons*
Royal tern	*Sterna maxima*
Western gull	*Larus occidentalis*
RAPTORS	
Peregrine falcon	*Falco peregrinus*
SHOREBIRDS	
American oystercatcher	*Haematopus palliatus*
Black oystercatcher	*Haematopus bachmani*
Northern phalarope	*Phalaropus lobatus*
Sanderling	*Calidris alba*
Western snowy plover	*Charadrius alexandrinus*
Willet	*Catoptrophorus semipalmatus*
WADING BIRDS	
Black-crowned night heron	*Nycticorax nycticorax*
Black rail	*Laterallus jamaicensis*
California black rail	*Laterallus jamaicensis coturniculus*
Light-footed clapper rail	*Rallus longirostris levipes*
WATERFOWL	
American coot	*Fulica americana*
American wigeon	*Anas americana*
Black brant	*Branta bernicla*
Canvasback	*Aythya valisineria*
Greater scaup	*Aythya marila*
Green-winged teal	*Anas crecca*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Red-breasted merganser	*Mergus serrator*
Snow goose	*Chen caerulescens*
Surf scoter	*Melanitta perspicillata*
FISH	
ANADROMOUS	
Coho salmon (silver)	*Oncorhynchus kisutch*
Rainbow trout (steelhead)	*Oncorhynchus mykiss*
BEACH SPAWNERS	
California grunion	*Leuresthes tenuis*
Surf smelt	*Hypomesus pretiosus*
SPECIAL CONCENTRATIONS	
Barred sand bass	*Paralabrax nebulifer*
C-O turbot	*Pleuronichthys coenosus*
Cabezon	*Scorpaenichthys marmoratus*
California barracuda	*Sphyraena argentea*
California corbina	*Menticirrhus undulatus*
California halibut	*Paralichthys californicus*
Kelp bass	*Paralabrax clathratus*
Mullet	*Mugil cephalus*
Opaleye	*Girella nigricans*
Rockfish	*Sebastes spp.*
Shortfin corvina	*Cynoscion parvipinnis*
Spotfin croaker	*Roncador stearnsii*
Spotted sand bass	*Paralabrax maculatofasciatus*
Starry flounder	*Platichthys stellatus*
Surfperch	*Embiotocidae*

SPECIES LIST*

Common Name	Species Name
FISH (continued)	
Tidewater goby	*Eucyclogobius newberryi*
Topsmelt	*Atherinops affinis*
White seabass	*Atractoscion nobilis*
Yellowfin croaker	*Umbrina roncador*
Yellowtail rockfish	*Sebastes flavidus*
MAMMALS	
DOLPHINS	
Bottlenose dolphin	*Tursiops truncatus*
Common dolphin	*Delphinus delphis*
Risso's dolphin	*Grampus griseus*
SEA OTTERS	
Sea otter	*Enhydra lutris*
SEALS AND SEA LIONS	
Harbor seal	*Phoca vitulina*
Guadalupe fur seal	*Arctocephalus townsendi*
Northern elephant seal	*Mirounga angustirostris*
California sea lion	*Zalophus californianus*
Northern fur seal	*Callorhinus ursinus*
WHALES	
Gray whale	*Eschrichtius robustus*
REPTILES	
TURTLES	
Pacific green sea turtle	*Chelonia mydas agassizi*
PLANTS	
KELP AND SEAGRASSES	
Eelgrass	*Zostera marina*
Giant kelp	*Macrocystis pyrifera*
Surfgrass	*Phyllospadix spp.*
TERRESTRIAL PLANTS	
Salt marsh bird's-beak	*Cordylanthus maritimus maritimus*
SHELLFISH	
BIVALVES	
California jackknife clam	*Tagelus californianus*
Common Pacific littleneck clam	*Protothaca staminea*
Gaper clam	*Tresus nuttallii*
Pacific razor clam	*Siliqua patula*
Pismo clam	*Tivela stultorum*
Sunset clam	*Gari californica*
Washington clam	*Saxidomus nuttallii*
California mussel	*Mytilus californianus*
Rock scallop	*Hinnites multirugosus*
Speckled scallop	*Argopectin circularis*
CRABS	
Red rock crab	*Pachygrapsus crassipes*
Rock crab	*Cancer spp.*
ECHINODERMS	
Red sea urchin	*Strongylocentrotus franciscanus*
GASTROPODS AND ABALONE	
Nuttall's cockle (basket, heart)	*Clinocardium nuttallii*
Abalone	*Haliotis sp.*
Black abalone	*Haliotis cracherodii*
Green abalone	*Haliotis fulgens*
Pink abalone	*Haliotis corrugata*
Red abalone	*Haliotis rufescens*
LOBSTER	
California spiny lobster	*Panulirus interruptus*
SQUID AND OCTOPUS	
Pacific coast squid	*Loligo opalescens*
Octopus	*Octopus spp.*

* Threatened and endangered species are designated by underlining.

Shorline Habitat Descriptions

EXPOSED ROCKY CLIFFS **ESI = 1A and 1C**

DESCRIPTION

- The intertidal zone is steep (greater than 30° slope), with very little width.
- Sediment accumulations are uncommon and usually ephemeral (classified as 1A), because waves remove the debris that has slumped from the eroding cliffs.
- Where large boulders have accumulated as talus at the base of the cliff, the shoreline has been classified as 1C.
- This shoreline type is seldom used in combination with another shoreline type, however they are often found interspersed with wave-cut platforms.
- There is strong vertical zonation of intertidal biological communities.
- Species density and diversity vary greatly, but barnacles, snails, mussels, seastars, limpets, sea anemones, shore crabs, polychaetes, and macroalgae are often very abundant.
- They are common throughout southern California, comprising about 11.8 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Oil is held offshore by wave reflecting off the steep cliffs.
- Any oil that is deposited is rapidly removed from exposed faces.
- The most resistant oil would remain as a patchy band at or above the high-tide line.
- Impacts to intertidal communities are expected to be short-term duration. An exception would be where heavy concentrations of a light refined product came ashore very quickly.

RESPONSE CONSIDERATIONS

- Cleanup is usually not required.
- Access can be difficult and dangerous.

EXPOSED SEAWALLS **ESI = 1B**

DESCRIPTION

- Seawalls occur in developed areas to provide protection to residential and industrial developments.
- They are composed of concrete or metal bulkheads.
- Organisms, such as barnacles, mussels, and algae, may be common on the lower levels, whereas biota along the upper intertidal zones is sparse.
- They comprise about 1.2 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Oil would percolate between the joints of the structures.
- Oil would coat the intertidal areas of solid structures.
- Biota would be impacted under heavy accumulations.

RESPONSE CONSIDERATIONS

- High-pressure spraying may be required in order to:
  - remove oil;
  - prepare substrate for recolonization of barnacle and mussel communities;
  - minimize aesthetic damage;
  - prevent the chronic leaching of oil from the structure.

EXPOSED WAVE-CUT PLATFORMS **ESI = 2**

DESCRIPTION

- The intertidal zone consists of a flat rock bench of highly variable width.
- The shoreline may be backed by a steep scarp or low bluff.
- There may be a perched beach of sand- to boulder-sized sediments at the base of the scarp.
- The platform surface is irregular and tidal pools are common.
- Small accumulations of gravel can be found in the tidal pools and crevices in the platform.
- These habitats can support large populations of encrusting animals and plants, with rich tidal pool communities. Dominant species include barnacles, snails, mussels, seastars, limpets, sea anemones, shore crabs, and polychaetes.
- In southern California, they represent 14.6 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Oil will not adhere to the rock platform, but rather be transported across the platform and accumulate along the high-tide line.
- Oil can penetrate in beach sediments, if present.
- Persistence of oiled sediments is usually short-term, except in wave shadows or larger sediment accumulations.

RESPONSE CONSIDERATIONS

- Cleanup is usually not required.
- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and oiled debris.

Fine- to Medium-Grained Sand Beaches ESI = 3

DESCRIPTION

- These beaches are generally flat, wide, and hard-packed.
- They can occur at the upper intertidal zone on wave-cut platforms.
- Where gravel storm berms occur in the upper intertidal zone, they are also denoted on the maps.
- There can be significant seasonal changes in the beach sediments as well as the width and slope of the beach.
- Upper beach fauna are scarce; lower beach fauna (particularly *Emerita*) can be dense, but are highly variable.
- These beaches are very common, comprising 23.1 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
- Heavy oil accumulations will cover the entire beach surface; the oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine-grained sand is about 10 cm and into medium-grained sand is about 15 cm.
- Burial of oiled layers by clean sand within the first few weeks will be less than 30 cm along the upper beach face.
- Organisms living in the beach may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in infaunal populations, which can also affect important shorebird foraging areas.

RESPONSE CONSIDERATIONS

- These beaches are among the easiest beach types to clean.
- Cleanup should concentrate on the removal of oil from the upper swash zone after all oil has come ashore.
- Activity through both oiled and dune areas should be severely limited, to prevent contamination of clean areas.
- Manual cleanup, rather than road graders and front-end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic.

COARSE-GRAINED SAND TO GRANULE BEACHES ESI = 4

DESCRIPTION

- These beaches are moderate-to-steep, of variable width, and have soft sediments.
- They commonly occur along beaches at river mouths.
- They are commonly backed by dunes or rocky cliffs along exposed, outer coasts.
- Generally species density and diversity is lower than on fine-grained sand beaches.
- They are common and comprise 5.6 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- During small spills, oil will be deposited primarily as a band along the high-tide line.
- Under very heavy accumulations, oil may spread across the entire beach face, though the oil will be lifted off the lower part of the beach with the rising tide.
- Penetration of oil into coarse-grained sand can reach 25 cm.
- Burial of oiled layers by clean sand can be rapid, and to depths of 60 cm or more.
- Burial to depths over one meter is possible if the oil comes ashore at the start of a depositional period.
- Biological impacts include temporary declines in infaunal populations, which can also affect important shorebird foraging areas.

RESPONSE CONSIDERATIONS

- Remove oil primarily from the upper swash lines.
- Removal of sediment should be limited to avoid erosion problems.
- Mechanical reworking of the sediment into the surf zone may be used to release the oil without sediment removal.
- Activity in the oiled sand should be limited to prevent mixing oil deeper into the beach.
- Use of heavy equipment for oil/sand removal may result in the removal of excessive amounts of sand; manual cleanup may be more effective.

MIXED SAND AND GRAVEL BEACHES ESI = 5

DESCRIPTION

- Moderately sloping beach composed of a mixture of sand and gravel (less the 80 percent of dominant fraction).
- Because of the mixed sediment sizes, there may be zones of pure sand, pebbles, or cobbles.
- There can be large-scale changes in the sediment distribution patterns depending upon season, because of the transport of the sand fraction offshore during storms.
- Because of sediment desiccation and mobility on exposed beaches, there are low densities of attached animals and plants.
- The presence of attached algae, mussels, and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota.
- They comprise over 2.7 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- During small spills, oil will be deposited along and above the high-tide swash.
- Large spills will spread across the entire intertidal area.
- Oil penetration into the beach sediments may be up to 50 cm; however, the sand fraction can be quite mobile, and oil behavior is much like on a sand beach if the sand fraction exceeds about 40 percent.
- Burial of oil may be deep at and above the high-tide line, where oil tends to persist, particularly where beaches are only intermittently exposed to waves.
- In sheltered pockets on the beach, pavements of asphalted sediments can form if there is no removal of heavy oil accumulations, because most of the oil remains on the surface.
- Once formed, these asphalt pavements can persist for many years.
- Oil can be stranded in the coarse sediments on the lower part of the beach, particularly if the oil is weathered or emulsified.

RESPONSE CONSIDERATIONS

- Remove heavy accumulations of pooled oil from the upper beachface.
- All oiled debris should be removed.
- Sediment removal should be limited as much as possible.
- Low-pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents. High-pressure spraying should be avoided because of potential for transporting contaminated finer sediments (sand) to the lower intertidal or subtidal zones.
- Mechanical reworking of oiled sediments from the high-tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity (as evidenced by storm berms). However, oiled sediments should not be relocated below the mid-tide zone.
- In-place tilling may be used to reach deeply buried oil layers in the middle zone on exposed beaches.

GRAVEL BEACHES ESI = 6A

DESCRIPTION

- Gravel beaches are composed of sediments ranging in size from pebbles to boulders.
- They can be very steep, with multiple wave-built berms forming the upper beach.
- Attached animals and plants are usually restricted to the lowest parts of the beach, where the sediments are less mobile.
- The presence of attached algae, mussels, and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota.
- They are common adjacent to cliffs and platforms, comprising nearly 9.9 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Deep penetration and rapid burial of stranded oil is likely on exposed beaches.
- On exposed beaches, oil can be pushed over the high-tide and storm berms, pooling and persisting above the normal zone of wave wash.
- Long-term persistence will be controlled by the depth of penetration versus the depth of routine reworking by storm waves.
- On the more sheltered portions of beaches, formation of asphalt pavements is likely where accumulations are heavy.

RESPONSE CONSIDERATIONS

- Heavy accumulations of pooled oil should be removed quickly from the upper beach.
- All oiled debris should be removed.
- Sediment removal should be limited as much as possible.
- Low- to high-pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents.
- Mechanical reworking of oiled sediments from the high-tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity (as evidenced by storm berms). However, oiled sediments should not be relocated below the mid-tide zone.
- In-place tilling may be used to reach deeply buried oil layers in the middle intertidal zone on exposed beaches.

RIPRAP **ESI = 6B**

DESCRIPTION

- Riprap structures are composed of cobble- to boulder-sized rock fragments.
- Riprap structures are placed for shoreline protection and inlet stabilization.
- Mid- and low-intertidal zone biota on the riprap may be plentiful and varied.
- Riprap structures are relatively common in southern California, representing 13.1 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Deep penetration of oil between the boulders is likely.
- Oil adheres readily to the rough rock surfaces.
- If oil is left uncleaned, it may cause chronic leaching until the oil asphaltizes.
- Resident fauna and flora may be killed by the oil.

RESPONSE CONSIDERATIONS

- When the oil is fresh and liquid, high-pressure spraying and/or water flooding may be effective, making sure to recover all released oil.
- Heavy and weathered oils are more difficult to remove, requiring scrapping and/or hot-water spraying.
- It may be necessary to remove heavily oiled riprap and replace it.

EXPOSED TIDAL FLATS **ESI = 7**

DESCRIPTION

- They are composed primarily of sand and mud.
- The presence of sand indicates that tidal or wind-driven currents and waves are strong enough to mobilize the sediments.
- They are usually associated with another shoreline type on the landward side of the flat.
- They occur in bays and along the lower sections of rivers.
- The sediments usually remain water-saturated, with only the topographically higher ridges drying out during low tide.
- Biological utilization can be very high, with large numbers of infauna, heavy use by birds for roosting and foraging, and use as haulouts for marine mammals.
- In southern California, they comprise nearly 1.9 percent of the shoreline length.

PREDICTED OIL BEHAVIOR

- Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur on a falling tide if concentrations are heavy.
- Oil does not penetrate water-saturated sediments.
- Biological damage may be severe, primarily to infauna, thereby reducing food sources for birds and other predators.

RESPONSE CONSIDERATIONS

- Currents and waves can be very effective in natural removal of the oil.
- Cleanup is very difficult (and possible only during low tides).
- The use of heavy machinery should be restricted to prevent mixing of oil into the sediments.
- On sand flats, oil will be removed naturally from the flat and deposited on the adjacent beaches where cleanup is more feasible.

SHELTERED ROCKY SHORES ESI = 8A

DESCRIPTION

- They are bedrock shores of variable slope (from vertical cliffs to wide, rocky ledges) that are sheltered from exposure to most wave and tidal energy.
- The wider shores may have some surface sediments, but the bedrock is the dominant substrate type
- Species density and diversity vary greatly, but barnacles, snails, mussels, seastars, limpets, sea anemones, shore crabs, polychaetes, and macroalgae are often very abundant.
- Sheltered rocky shores are rare in southern California, comprising about 0.1 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- Oil will adhere readily to the rough rocky surface, particularly along the high-tide line, forming a distinct oil band.
- Even on wide ledges, the lower intertidal zone usually stays wet (particularly when algae covered), preventing oil from adhering to the rock surface.
- Heavy and weathered oils can cover the upper zone with little impacts to the rich biological communities of the lower zone.
- Where surface sediments are abundant, oil will penetrate into the crevices formed by the surface rubble and pool at the contact of the sediments and the rock surface.
- Where the rubble is loosely packed, oil will penetrate deeply, causing long-term contamination of the subsurface sediments.

RESPONSE CONSIDERATIONS

- Low- to high-pressure spraying at ambient water temperatures is most effective when the oil is fresh.
- Extreme care must be taken not to spray in the biologically rich lower intertidal zone or when the tidal level reaches that zone.
- Cutting of oiled, attached algae is not recommended; tidal action will eventually float this oil off, so sorbent booms should be deployed.

SHELTERED MAN-MADE STRUCTURES ESI = 8B

DESCRIPTION

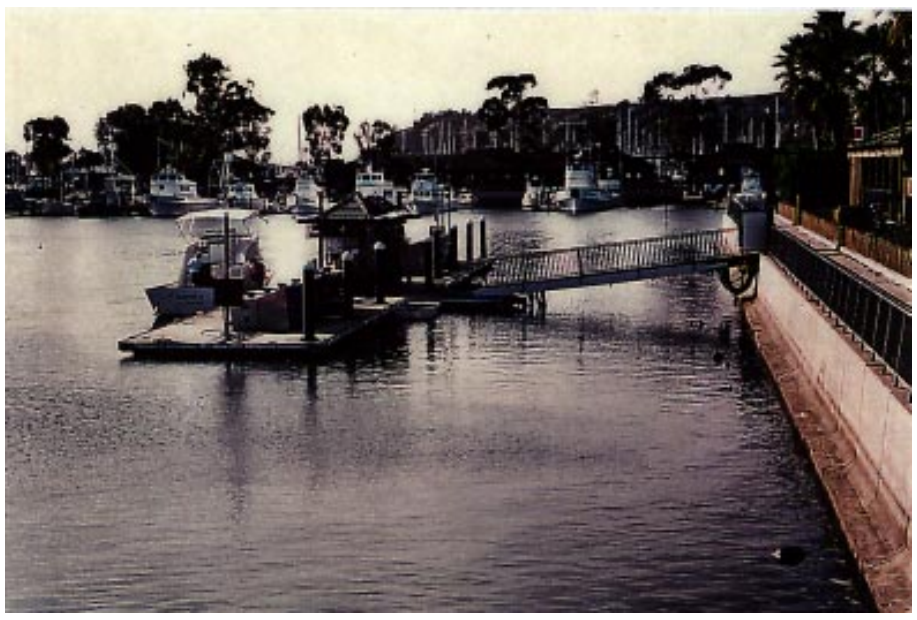
- These structures include revetments, seawalls, piers, and docks constructed of impermeable materials such as concrete.
- They are found inside harbors and bays in highly developed areas, sheltered from direct exposure to waves.
- They are common, comprising 18.7 percent of the shoreline.

PREDICTED OIL BEHAVIOR

- On impermeable surfaces, the oil will form a band at the high-tide line.
- If the oil is not removed, it may cause chronic leaching until the oil hardens into an asphalt deposit.

RESPONSE CONSIDERATIONS

- High-pressure spraying may be required to remove oil for aesthetic reasons and to prevent leaching of oil from the structure.
- Cleanup crews should make sure to recover all released oil.



SHELTERED TIDAL FLATS ESI = 9

DESCRIPTION

- Sheltered tidal flats are composed primarily of silt and clay.
- They are present in calm-water habitats, sheltered from major wave activity, and are frequently fronted by marshes.
- Wave energy is very low, although there may be strong tidal currents on parts of the flat and in channels across the flat.
- The sediments are very soft and cannot support even light foot traffic.
- There can be large populations of clams, worms, and snails.
- Bird life is seasonally abundant.
- Sheltered tidal flats are very uncommon, comprising 0.8 percent of the shoreline length.

PREDICTED OIL BEHAVIOR

- Oil does not usually adhere to the surface of sheltered tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur on a falling tide if concentrations are heavy.
- Oil will not penetrate the water-saturated sediments at all.
- In areas of high suspended sediments, sorption of oil can result in deposition of contaminated sediments on the flats.
- Biological damage may be severe.

RESPONSE CONSIDERATIONS

- These are high-priority areas necessitating the use of spill protection devices to limit oil-spill impact; deflection or sorbent booms and open water skimmers should be used.
- Cleanup of the flat surface is very difficult because of the soft substrate and many methods may be restricted.
- Manual operations and deployment of sorbents from shallow-draft boats may be helpful.

MARSHES ESI = 10

DESCRIPTION

- Marshes are intertidal wetlands containing emergent, herbaceous vegetation.
- Width of the marsh can vary widely, from a narrow fringe to extensive areas.
- They are relatively sheltered from waves and strong tidal currents.
- Resident flora and fauna are abundant with numerous species.
- Bird life is seasonally abundant.
- Marshes are found mostly in major bays, such as Humbolt Bay and Tomales Bay, and at river mouths, such as Ten Mile River and Mad River.
- They comprise about 6.3 percent of the shoreline length.

PREDICTED OIL BEHAVIOR

- Oil adheres readily to marsh vegetation.
- The band of coating will vary widely, depending upon the tidal stage at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem from the high-tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, with penetration and lighter oiling to the limit of tidal influence.
- Medium to heavy oils do not readily adhere or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and cracks (up to one meter).

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is to let the area recover naturally.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at great risk from leaving the oiled vegetation in place.